Innovation and Industrial Clusters

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Abstract: On this case study the aim was to understand the mechanisms for knowledge acquisition and its transformation in innovation performance by Portuguese firms of the moulds industrial sector. Emphasis was put on the study of interactions between several external or internal elements of the system. Information obtained through intensive observation and study of eight firms of the moulds sector, all located in the region of Marinha Grande, in Portugal, allowed for the creation of an observation model of the moulds sector, in relation to the type of existing interactions between firms and between firms and other institutions. The study permits systematization and generalisation in the analysis of the innovative dynamics of this sector.

Keywords: Industrial districts; innovation; Portugal; moulds sector; technological collaboration; systems of innovation; networks of innovation; firm performance; firm taxonomy.

1 Introduction

On this case study the aim was to understand the mechanisms for knowledge acquisition and its transformation in innovation performance by Portuguese firms of the moulds industrial sector. Emphasis was put on the study of interactions between several external or internal elements of the system. The two main research questions were: 1) If innovation reflects learning [1] how do firms learn, how do firms transpose learning and are able to innovate? 2) What are the reasons for the innovative performance of the moulds sector in Portugal? The study resulted in the creation and proposal of an observation model of the moulds sector, relative to the type of relations that exist between the firms and between firms and other institutions, which permits systematization and generalisation in the analysis of the innovative dynamics of this sector. The innovative performance of the sector is also related with several of its intrinsic characteristics. By studying the firms, and the existing interactions, characteristics that are peculiar to the

Italian industrial districts were noticed. This sector possesses some strong characteristics of industrial districts that have influenced and conditioned its innovative performance.

2 A review of the literature

It is widely acknowledged that innovation is a key factor for competitiveness and that output growth and productivity depend on the development and diffusion of new technologies [2]. However, the innovation process is not linear, but a complex and interactive one, involving business and non-business institutions. Kline and Rosenberg's "chain-linked" interactive model [3] is an example of an innovation model that shows its interactive nature. Innovation is not the produce of a single inventive actor, but is the result of institutional and organizational interactions.

Accounting for its discontinuities and uncertainties, the concept of national innovation systems help understand why technologies develop within certain trajectories. In the study of national innovation systems, the interactions between the several elements that constitute the innovation system, including firms, academia and research institutions, as well as other institutional actors, are analysed [4]. The firms are at the core of this system, competing but also cooperating with each other [5] (Dosi, Freeman, Nelson, Silverberg & Soete, 1988).

Several authors [6] refer the importance of the interactions between firms and the social and economic environment where they are inserted, and the connections that are established with consulting firms and science and technology infrastructure institutions, emphasising the importance of R&D centres, and education and training institutions. Optimization of these interactions results in the establishment of (business and innovation) networks that thrive on the complementarities of competences or assets, on mutual dependence and in new forms of economic organizational forms not primordially governed by contractual bind but by relations based on trust and risk and benefit sharing [7].

Firms that show high levels of technological collaboration, either with other firms or with universities or research institutions, and acquisition of technology and mobility of human resources, are able to improve their innovative capacity both in terms of product and process. The easiness with which knowledge is transferred depends on its type. Explicit knowledge is formal and systematic, and it is associated with product specifications, formulae or computer software. Tacit knowledge is partly technical capacity, but it also has a cognitive dimension formed by mental models and perspectives, which are difficult to articulate. Socialization is the only way to transfer tacit knowledge between individuals, through observation, imitation and practice [8].

Maybe because of that, geography and regions seem to have an accentuated importance for the development of systems and networks of new technologies. Local infrastructures, specialized human resources, local labour market, specialized services and personal relations are fundamental and contribute decisively to regional development [9].

Regions are associated with concepts like cluster [10] or geographical cluster of small and medium enterprises [11], also defined as industrial district [12]. Clusters are considered as a strategic opportunity for small and medium enterprises to prosper in certain industrial sectors, because firms located in clusters seem to be potentially more innovative than those that are not. That seems to be due to the fact that geographic or

strategic proximity facilitate knowledge exchange between firms and other firms or other institutions [13].

Industrial districts are defined in the literature as production systems geographically concentrated, constituted by a large number of small and medium firms, which are involved in several production phases of the same product or product family. These firms are highly but differentially specialized in several phases of the production process, and their integration is done through the establishment of connections and cooperative agreements between those firms [14].

Starting from Becattini's definition of industrial district and based on several other works [15], it is possible to enumerate a set of factors that characterises the industrial district concept:

1. There are many small and medium enterprises in a defined territory, with the same type of flexible production system;
2. There are strong cooperation links between firms, based on trust;
3. Besides the links between firms, there are relations between firms and local institutions that are connected to other firms and institutions located outside the district;
4. Firms specialise in one or some, but not all, phases of the production process, of a specific product or family of products (that can be intermediary or final products), resulting in the division of labour between firms (and not within n firms). Each industrial district is associated with a product, which becomes distinctive of that district;
5. Production is flexible and responds to customer needs. Firms have the capacity to produce systems of products;
6. Independently of firm size, some firms sell directly to the final consumer, other manufacture only a part of the product or are engaged only in a part of the production phase;
7. The division between firms that sell directly their products to the final consumer or firms that are subcontracted by other firms is not rigid; both roles can be assumed by the same firm at the same time, or at different periods;
8. Relations between firms that sell directly to the market are, at the same time, of competition and cooperation; firms do not enter in conflict with each other, trying to find new markets and avoiding a destructive effect on the district;
9. There is a strong relation inside the district, namely between the productive structure and its socio-economic surroundings, existing, in a certain sense, a fusion between the firms and the community, due to the homogeneity of values; this is a fundamental requirement for the development of industrial districts;
10. "Pure" entrepreneurs in industrial districts are quite frequent. They act as imitators, adopters and improvers of international "state-of-the-art" technology in terms of products and processes;
11. The presence of leading firms that provide and help expand an international dimension to the district;

12. Human resource mobility. This characteristic is very important, because knowledge is embedded in people and not in the firms. The great mobility of human resources allows the diffusion of tacit knowledge throughout the firms of the district, and it maintains an ongoing collective learning process.

Associated to the notion of industrial districts is, thus, the existence of a intricate web of informal and formal relationships between the several constituent actors, namely enterprises, local institutions (research, education, training), leading enterprises, and specialized enterprises [16], that provide for the exchange of knowledge and resources. Molina-Morales & Martinez-Fernandéz [17] argue that industrial districts allow for resource sharing, which is behind the competitive advantages of the firms that constitute it, due to the fact that: 1) they share the same reputation,; 2) there is an intense exchange and combination of resources, 3) local institutions are deeply involved in the process.

3 An observation model for innovative firms of the moulds sector

Information obtained through intensive observation and study of eight firms of the moulds sector, all located in the region of Marinha Grande, in Portugal, allowed for the creation of an observation model of the moulds sector (Table 1), in relation to the type of existing interactions between firms and between firms and other institutions. Firms were not randomly chosen, and it was determinant for their inclusion in the sample their innovative reputation or performance. Although all the sample firms belong to the same industrial sector, different characteristics have emerged, allowing their grouping and classification along the lines of a value chain. Some of the firms are typically and almost exclusively producers, and their project and engineering capacity is very limited. R&D activities and product engineering and design activities are non-existent. A second category of firms have very well developed project and engineering capacities, as well as productive capacity, and are able to develop innovative solutions to demanding costumers. Information sources for innovation are essentially internal, coming out of R&D, and product engineering and design activities, developed internally. There is another category of firms that have no internal production capacity, which is contracted out to other firms. The firms have different innovative behaviours, depending on the partner with whom informal relations are established.

Producer firms

Firms that fall in this category have a high preponderance to develop process innovations, which is related to their high costumer dependency, in terms of product conception. Product conception and development is, generally, made externally, by the costumer.

In this type of enterprises, internal competencies necessary for the generation of ideas for product innovation are scarce. The main sources of ideas for innovation are the costumers and, principally, suppliers of machines and equipment. It is the requirements and the demands of the costumer, in terms of product specifications, that compel the development of the production process. Costumers are the great drivers for the acquisition of new equipments that allow for the satisfaction of the requirements. Extended visits and training periods in client firms, made under the initiative of the later, are frequent, and constitute some of the main mechanisms by which the firms update their skills and knowledge base.

The relationships with research institutions are tenuous or inexistent. Connections with universities do not exist, although firms are aware of their potential importance. There are some relations with sectoral technological centres, namely to obtain training in generic areas. Typically, these are subcontracted firms whose technological evolution depends on costumer knowledge transfer and demand.

Firms with engineering/project and production

These firms have a quite developed component of engineering and project, as well as a developed production component. They are able to provide innovative solutions to the costumers, autonomously. The level of dependency on their costumers is very reduced, unlike the firms in the previous category, as they possess sufficient know-how and competencies to provide the solutions costumers are seeking for. These firms have consistent relations with research institutions, although the perception is that those relations should be more frequent. There are interactions with several types of institutions, including universities, as well as research institutes and sectoral technological centres. These institutions function as partners in the solution of technical problems that firms face in their product design and development activities as well as in their production activities. Internal design and engineering capacities, coupled with the previous mentioned sources of external knowledge, constitute the mechanisms for knowledge appropriation and utilisation. Product innovation is perceived as more important than process innovation, and firms pursue an active product diversification strategy.

Commercial firm (Broker)

The third group of firms, which act as brokers, have a mixed behaviour compared with the other two previous groups. The firms do not have internal production capacities. All production is contracted out to firms that are exclusively producers (the first category of firms). There is a variable engineering and project capacity (depending on the firm), an acute knowledge of the market and a high commercial performance. The characteristics of the firms in this group are situated between the “extremes” represented by the other two groups, but they are different in fundamental ways.

Table 1 An innovation observation model of the moulds sector in Portugal

Type of firm	*Core competency*	*Source of ideas*	*Main type of innovation*	*Costumer dependency*
Producer	Production	External	Process	Strong
Engineering/Project and Production	Product design	Internal	Product	Weak
Commercial (Broker)	Market	Mixed	Mixed	Mixed

Table 2 An innovation observation model of the moulds sector in Portugal (continued)

Type of firm	*Relations with suppliers of*			*Relations with competitors*[1]
	Raw materials[2]	*Machines and equipment*	*Software*	
Producer	Weak	Strong	Strong	Strong
Engineering/Project and Production	Weak	Strong	Strong	Strong
Commercial (Broker)	Weak	Strong	Strong	Strong

[1] Occurring only with some competitors, relative to which the classification is made.

[2] Referring mainly to steel suppliers.

Table 3 An innovation observation model of the moulds sector in Portugal (continued)

Type of firm	*Relations with academic institutions*	*Relations with research centres*	*Relations with training centres*
Producer	Weak or inexistent	Weak or inexistent	Strong
Engineering/Project and Production	Strong [3]	Strong	Weak
Commercial (Broker)	Weak	Weak	Weak

[3] Considered strong when compared with the other groups, although its intensity is still quite low.

The majority of the firms do not have internal design and development capabilities, serving as intermediaries between product conception and specification (generally done by the costumer firm), and the production firm. However, there is a considerable variety within this category, and there are firms in this group that have strong internal project, design and engineering capacities, which make them similar to the second group. In any case, commercial competencies, and the absence of internal production are the distinctive and strong features of firms in this group.

This type of firms is fundamental for the survival of many firms of the moulds sector. They fulfil two functions that seem to be essential for many firms. The first is a commercial function of connection to external markets, that is absent from many firms

(typically of the first group). Trough the provision of this function, a substantial part of production of many firms is sold to external markets. A second function is related with the management of orders and product portfolio [18], and the realization of scale economies, through the coordination of the production activities of a set of enterprises. Commercial firms take advantage of the incapability of many firms to respond to, or manage, large orders and corresponding integration and delivery times, and have built internal capacities of coordination that distribute production and capacity trough a network of producer firms, creating the facto extended or virtual enterprises [19]. There are variations on the functions that are assured by the extended firm, as stated above.

4 Innovative capacity of the moulds sector and industrial districts characteristics

In spite of the heterogeneous behaviour of the firms, which are determined by their specialization and knowledge acquisition capacities, all of them relate to firms that are competitors (an interaction that depends essentially on the level of trust that is present) and establish strong informal relations, which include visits to each one's premises and personal relationships between managers, and that seems to be a peculiar trait of this sector. It is important to note that knowledge exchange between competitors is not made indiscriminately, but solely with those partners that assure a relation based on reciprocity, and where the transaction of information and knowledge benefits both parties [20].

Detailed analysis of the relationships between firms and their partners, and the importance of such connections for the innovative performance of the firms in particular, and the sector in general, suggested a possible comparison with (Italian) industrial districts. Industrial districts are a particular form of industrial organization, and it is acknowledged its importance in the development of traditional sectors, where mature technologies are of fundamental importance. This type of industrial organization is also present in other countries, although it is almost, if not exclusively, associated with traditional sectors, such as for instance, the ceramics sector in Spain, in the region of Castelón [21] and the textile sector in Germany, in the region of Baden-Wurttemberg [22].

Based on the industrial reality of the region of Marinha Grande, in Portugal, and having as reference the Italian industrial districts, it is possible to observe similarities between the two realities, including the presence of a large number of small and medium enterprises in a well defined region, in a well defined traditional industrial sector and showing a considerable level of differential specialization and flexibility. The moulds sector in Marinha Grande has grown rapidly, in a process of creation of spin-off firms from other larger firms. Competitive behaviour between firms is strong, but so it is cooperative behaviour, largely based in informal mechanisms. Subcontracting is frequent and firm specialization in production phases also. Regional resource utilization is common, although many resources necessary to the production process are not manufactured in the region. There are local institutions that provide some of those resources. Leading, highly innovative, export oriented enterprises, essential drivers of the process of sector development, are characteristic of industrial districts and they are not an exception in this case.

In spite of the similarities with other well documented realities concerning industrial districts, the intensity with which they occur, in this case study, is rather different. The

cooperative relations between competitive firms is restricted to a few examples, and sustained by strong personal relations based on trust. The number of subcontracted enterprises is also reduced compared with the Italian reality, because the division of labour is not so accentuated, and the level of specialization in the different manufacturing phases is more reduced. Firms subcontract phases of the production process as well as the entire process.

Another distinct characteristic of industrial districts is the local utilization and provision of all, or at least, the most important resources for the manufacturing of the product that identifies the industrial district. In the case of Marinha Grande, it was observed that the level of utilisation of local resources is also lower if compared with other districts. Some of those resources are not provided locally, or their utilization is reduced. For example there are no local (or national) suppliers of equipment goods for the moulds sector, and all the equipment and associated technology is imported from outside the boundaries of the district or the national confines where it is enmeshed.

Another characteristic that distinguishes this sector from the more typical industrial district is the fact that the majority of the costumers are located outside the region. The internal market is not significant, and demand comes essentially from other countries. A large proportion of the sector output is exported, contrary to some districts where demand originates from inside the district. The group of firms referred previously under the title of commercial firms or brokers, bases its activity by taking advantage of this characteristic, bridging the final costumer (that is abroad) with the local firm. However, the largest and/or leading firms of the sector maintain close relations with their (foreign) costumers, and those relations have been an important source of information and knowledge, which has significantly contributed to the development of the sector as a whole.

The absence of some characteristic elements of industrial districts, such as local availability of resources linked to equipment goods and technology, and the low level of internal demand, does no invalidate the assumptions and conclusions that were made. Some authors [23] argue that geographic proximity is becoming less important for innovative activities performed by firms and consequently for regional development. Lazerson & Lorenzoni [24] argue that outside actors are often indispensable because they sow the seeds of future progress.

5 Conclusion

The main competitive advantage of this industrial sector is due to the strong relational capacity of its firms, independently of the position of the partner in the value chain of the product/sector. These relations are differentiated, either in terms of partners or in terms of intensity, and there seems to be a relation between the innovative capacity of the firm and the pattern of interactions that it maintains.

Specific features that can be found in other industrial districts, and particularities unique to the sector, are behind the innovative and competitive performance of the sector.

Future research tends to give special attention to the impact of non-local network effects on the patterns of relations that were based on geographic proximity.

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